

WHAT IS CLAIMED IS:

Jul 1
1. A power output apparatus comprising at least an engine and two
motors and causing power to be output from a drive shaft, said power
output apparatus comprising:

changeover means that changes over a connection state of the
engine and the two motors between a parallel connection mode, in which at
least part of output of the engine is transmitted in the form of mechanical
power to the drive shaft and at least one of the two motors is utilized as a
power source, and a series connection mode, in which at least one of the
two motors converts the output of the engine into electric power and the
other motor reconverts the electric power into mechanical power and
outputs the mechanical power to the drive shaft.

15 2. A power output apparatus in accordance with claim 1, wherein
one of the two motors functions as a power regulation unit, which has at
least two rotating shafts and is capable of regulating magnitude of power
transmitted between the at least two rotating shafts through transmission
of electric power,

20 said power regulation unit and the other motor are arranged in
series between an output shaft of the engine and the drive shaft, and
said changeover means comprises:

a connection mechanism that connects and disconnects the power
regulation unit with and from the other motor; and

25 a constraint mechanism that constrains one of the at least two
rotating shafts in said power regulation unit and thereby allows
conversion between electric power and mechanical power in said power
regulation unit in a released position of the connection mechanism.

30 3. A power output apparatus in accordance with claim 2, wherein

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said power regulation unit comprises a pair-rotor motor having two rotors
that are rotatable relative to each other.

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4. A power output apparatus in accordance with claim 2, wherein
5 said power regulation unit comprises a planetary gear unit having three
rotating shafts and a motor generator linked with one of the three rotating
shafts.

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4. A power output apparatus in accordance with claim 2, wherein
10 the constraint mechanism links the residual two rotating shafts of the
planetary gear unit with each other.

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6. A power output apparatus in accordance with claim 2, wherein
the constraint mechanism constrains rotation of a specific rotating shaft
15 that is linked with the connection mechanism, among the at least two
rotating shafts in said power regulation unit.

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7. A hybrid vehicle that has at least an engine and two motors
mounted thereon and is driven while causing power to be output from a
20 drive shaft, said hybrid vehicle comprising:

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changeover means that changes over a connection state of the
engine and the two motors between a parallel connection mode, in which at
least part of output of the engine is transmitted in the form of mechanical
power to the drive shaft and at least one of the two motors is utilized as a
25 power source, and a series connection mode, in which at least one of the
two motors converts the output of the engine into electric power and the
other motor reconverts the electric power into mechanical power and
outputs the mechanical power to the drive shaft.

30 8. A hybrid vehicle in accordance with claim 7, wherein one of the

two motors functions as a power regulation unit, which has at least two rotating shafts and is capable of regulating magnitude of power transmitted between the at least two rotating shafts through transmission of electric power,

5 said power regulation unit and the other motor are arranged in series between an output shaft of the engine and the drive shaft, and

 said changeover means comprises:

 a connection mechanism that connects and disconnects the power regulation unit with and from the other motor; and

10 a constraint mechanism that constrains one of the at least two rotating shafts in said power regulation unit and thereby allows conversion between electric power and mechanical power in said power regulation unit in a released position of the connection mechanism.

15 9. A hybrid vehicle in accordance with claim 8, wherein said power regulation unit comprises a pair-rotor motor having two rotors that are rotatable relative to each other.

20 10. A hybrid vehicle in accordance with claim 8, wherein said power regulation unit comprises a planetary gear unit having three rotating shafts and a motor generator linked with one of the three rotating shafts.

25 11. A hybrid vehicle in accordance with claim 10, wherein the constraint mechanism links the residual two rotating shafts of the planetary gear unit with each other.

30 12. A hybrid vehicle in accordance with claim 8, wherein the constraint mechanism constrains rotation of a specific rotating shaft that is linked with the connection mechanism, among the at least two rotating shafts in said power regulation unit.

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13. A hybrid vehicle in accordance with claim 7, said hybrid vehicle further comprising:

5 detection means that detects a predetermined parameter relating to a driving state of said hybrid vehicle; and

control means that controls said changeover means to change over the connection state, based on a result of the detection.

14. A hybrid vehicle in accordance with claim 13, wherein said 10 control means comprises:

a storage unit that stores a mapping of each range of the predetermined parameter to the connection state having a high driving efficiency; and

15 a unit that refers to the storage unit based on the result of the detection by said detection means and implements the changeover of the connection state.

15. A hybrid vehicle in accordance with claim 13, wherein said 20 detection means determines whether or not a current gearshift position is at a reverse position, and

said control means selects the series connection mode when it is determined that the current gearshift position is at the reverse position.

16. A hybrid vehicle in accordance with claim 13, wherein said 25 detection means determines whether or not said hybrid vehicle is at a stop, and

said control means selects the series connection mode when it is determined that said hybrid vehicle is at a stop.

30 17. A hybrid vehicle in accordance with claim 13, wherein said

detection means determines whether or not said hybrid vehicle is in a specific driving state that requires motoring of the engine, and

said control means selects the series connection mode when it is determined that said hybrid vehicle is in the specific driving state.

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18. A hybrid vehicle in accordance with claim 13, wherein said detection means determines whether or not said hybrid vehicle is in a certain driving state that requires a stop of the engine, and

10 said control means selects the series connection mode when it is determined that said hybrid vehicle is in the certain driving state.

19. A hybrid vehicle in accordance with claim 8, wherein said power regulation unit comprises a planetary gear unit having three rotating shafts and a motor generator linked with one of the three rotating shafts,

15 the constraint mechanism links the residual two rotating shafts of the planetary gear unit with each other,

 said detection means detects a required torque to be output from the drive shaft, and

20 said control means makes both the connection mechanism and the constraint mechanism in coupled positions when the required torque is not less than a preset value.

25 20. A hybrid vehicle in accordance with claim 8, said hybrid vehicle further comprising:

 resonance detection means that detects occurrence of a resonance on at least one of the output shaft of the engine and the drive shaft; and

 resonance suppression control means that, when the occurrence of the resonance is detected at any shaft, controls both the connection mechanism and the constraint mechanism to restrict a torque applied on 30 the shaft with the resonance.

21. A hybrid vehicle in accordance with claim 20, wherein said resonance suppression control means restricts the torque applied on the shaft with the resonance to be not greater than a torsional strength of the
5 shaft.

22. A hybrid vehicle in accordance with claim 20, wherein said resonance suppression control means restricts the torque applied on the shaft with the resonance to a specific level that causes no vibrations of
10 said hybrid vehicle.

23. A hybrid vehicle in accordance with claim 20, wherein said power regulation unit is linked with the engine,
said resonance detection means detects the occurrence of the
15 resonance on the output shaft of the engine in the released position of the connection mechanism and in an active position of the constraint mechanism, and

20 said resonance suppression control means reduces a force of constraint by the constraint mechanism when the occurrence of the resonance is detected.

24. A hybrid vehicle in accordance with claim 23, wherein said resonance detection means detects the occurrence of the resonance in the course of motoring the engine, and
25 said resonance suppression control means reduces the force of constraint by the constraint mechanism in a certain range that enables a specific torque, which allows motoring of the engine, to be added to the output shaft.

30 25. A hybrid vehicle in accordance with claim 20, wherein said

resonance detection means detects the occurrence of the resonance on the drive shaft in a coupled position of the connection mechanism, and

said resonance suppression control means reduces a force of connection by the connection mechanism when the occurrence of the
5 resonance is detected.

26. A hybrid vehicle in accordance with claim 25, wherein said resonance detection means detects the occurrence of the resonance in the course of braking said hybrid vehicle, and

10 said resonance suppression control means reduces the force of connection by the connection mechanism in a certain range that enables transmission of a specific torque, which is not less than a maximum regenerative torque applied by one of said power regulation unit and the other motor arranged closer to the engine.

15 27. A hybrid vehicle in accordance with claim 7, said hybrid vehicle further comprising:

route information input means that inputs route information relating to a driving state of said hybrid vehicle, with regard to a preset
20 driving route of said hybrid vehicle, and

said control means carries out the changeover by taking into account the route information.

28. A method of controlling a hybrid vehicle, said hybrid vehicle comprising: at least an engine and a motor as power source for causing power to be output from a drive shaft; and changeover means that changes over a connection state of the engine and the motor between a parallel connection mode, which transmits at least part of output of the engine to the drive shaft in the form of mechanical power, and a series connection mode, which converts the output of the engine into electric power and
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outputs the electric power to the drive shaft,
said method comprising the steps of:

- (a) detecting a predetermined parameter relating to a driving state
of said hybrid vehicle; and
- 5 (b) controlling said changeover means to change over the
connection state, based on a preset mapping of each range of the
predetermined parameter to the connection state.

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